IFIC SOUTHWEST
Forest and Range Experiment Station
FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE P.O. BOX 245, BERKELEY, CALIFORNIA 94701

SOIL-VEGETATION MAPS OF CALIFORNIA

Wilmer L. Colwell, Jr.

Published in cooperation
with the State of California:
The Resources Agency,
Department of Conservation,
Division of Forestry
University of California,
Division of
Agriculture Sciences

USDA FOREST SERVICE RESOURCE BULLETIN PSW-13 /1974

CONTENTS

THE AUTHOR

WILMER L. COLWELL, JR. is in charge of the Cooperative Soil-Vegetation Survey, headquartered at Berkeley, California. A 1938 forestry graduate of North Carolina State University, he also holds a master's degree (1950) from the University of California, Berkeley. He joined the Station staff in 1946.

ACKNOWLEDGMENTS

I thank the Soil-Vegetation Survey staff for their contributions to this publication: *James I. Mallory,* range conservationist, and *Benjamin F. Smith,* soil scientist, Pacific Southwest Forest and Range Experiment Station; and *Chester O. Stone,* forester, California Division of Forestry, for their contributions and critical review; and *W. Robert Powell,* associate specialist, in the Department of Agronomy and Range Science, University of California, Davis for his assistance in preparation of the explanations of the tables.

Basic information about soils and vegetation—their characteristics, location, extent, and relationships—is especially useful to the resource manager. It provides him with a foundation for understanding and managing the ecosystem—the ecological community that includes soils, vegetation, animals, climate, and man. By applying an ecological approach, he can make more efficient and productive use of the land and its resources. He can apply management procedures that have proved successful in areas of known soils and vegetation to other areas with the same characteristics.

Soil-vegetation surveys are designed to produce useful maps and information. The data are useful to the practitioner as well as to the researcher. In land management research, prior knowledge of the ecosystem is mandatory if the work is to succeed. If the vegetation is to be changed, the information from such surveys might be used to estimate probable results.

This publication contains information about the soil and vegetation symbols and other features shown on the 7½-minute soil-vegetation quadrangle maps. It also explains and defines the terminology used in the six tables that accompany each map.

The soil-vegetation maps were prepared by the California State Cooperative Soil-Vegetation Survey Project, Pacific Southwest Forest and Range Experiment Station, Forest Service. The Project is financed through appropriations of the California Legislature to the Division of Forestry, Department of Conservation, Resources Agency of California. Cooperating organizations in the Soil-Vegetation Survey are the Division of Forestry; the Department of Agronomy and Range Science, Department of Soils and Plant Nutrition, University of California, Davis; Department of Forestry and Conservation, University of California, Berkeley; and the Pacific Southwest Forest and Range Experiment Station at Berkeley. Project leader is Wilmer L. Colwell, Jr., Pacific Southwest Forest and Range Experiment Station at Berkeley.

The Soil-Vegetation maps are for sale only. The price of each 7½-minute quadrangle map is 45 cents. Tables accompany each map.

Order should state specifically which quadrangles are desired. Make checks or money orders for the exact amount (minimum orders are $1.00) payable to the Treasurer of the United States, and send to:

Regional Forester
U.S. Forest Service
630 Sansome Street
San Francisco, California 94111

For a list of available maps, write to the above address.

LEGEND TO THE MAPS

Base Maps

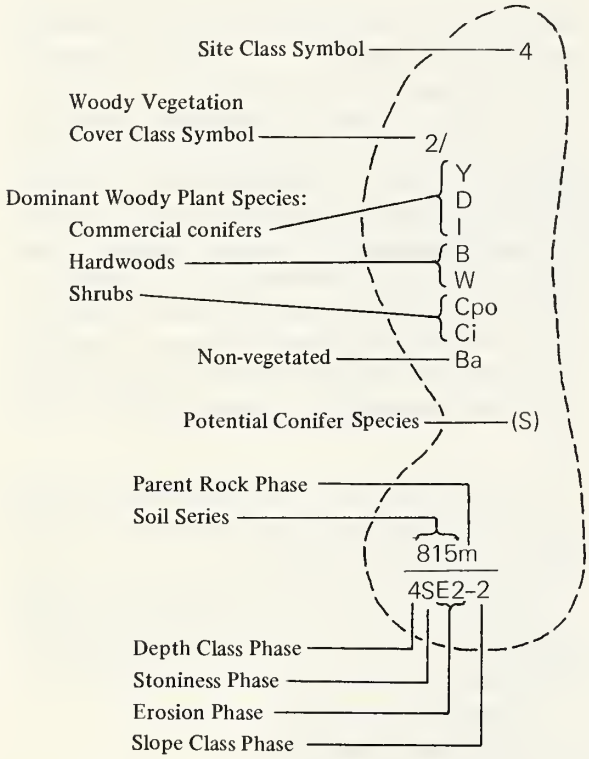
Base maps used for the Soil-Vegetation maps are specially prepared by the Pacific Southwest Forest and Range Experiment Station, mostly from published sources. Each Soil-Vegetation map consists of a standard 7½-minute quadrangle unit at the scale of 2 inches = 1 mile.

Every effort has been made to fit the soil and vegetation boundaries to the topography of the base map. Land subdivisions have been positioned as accurately as source information and map control points permit. If a precise fit of the data to land subdivisions for small areas is required, ground checks against known corner locations, fence boundaries, or other features should be carried out, preferably by using aerial photographs.

Contour lines, minor roads, small drainages, and other map details are not shown on the maps so as not to obliterate other data. If such map detail is required, refer to U.S. Geological Survey topographic maps, which are used as sources for the base information. The base maps are listed in the lower right corner of each quadrangle map.

Symbols Shown on the Maps

All soil and vegetation information for each mapping area is shown by coded symbols on the map as in the example below. Following this example are detailed explanations of the symbols.



Soil Symbols

Soils are mapped by soil series and phases (depth class, slope class, and certain other soil phases). The Soil Survey Manual (Soil Survey Staff 1951) has been used as a general standard of reference for terminology and concepts. Soil information is coded in the form of a numerical fraction, e.g.:

$$\frac{815m}{4SE\text{-}1} = \frac{\text{Soil Series/soil series modifier}}{\text{depth class/other phases/-slope class}}$$

Soil series can be coded in three categories defined as follows:

Soil series names are designated by numbers of three or four digits in the numerator of the fraction.

Soil series variants are soils of limited extent which are distinctly different, but similar and closely related to a known soil series. They are designated by the symbol "V" following the soil series symbol, e.g. 815V.

Soils of limited extent which are distinctly different from and unrelated to a known soil series are indicated by an "X," "Y," or "Z" instead of the final numeral in the soil series symbol, e.g. 84X.

Soil series modifiers give additional information about the soil series or indicate a variation from the normal characteristic of the series. They have special symbols and examples as defined below:

Parent rock or parent material phases are designated by a lower case letter following the soil series number, e.g. 815m.

Variations from normal are shown by upper case letters (different from any given above) following the soil series number, e.g. a landslide phase, 815L, or a taxadjunct, 815A, etc.

If there is more than one variant or taxadjunct of a given soil series designated by the same letter, each is numbered in succession, e.g.:

Soil series variants:	815V1, 815V2
Taxadjuncts:	815A1, 815A2

Other soil phases are designated by letters and numbers in the denominator of the fraction. Soil *depth class* is designated by the first digit. *Rockiness, stoniness, and/or erosion* are designated by letters and numbers immediately following the depth class symbol *(table 2)*. The *slope class* in the delineated area is represented by a letter or number symbol which is separated by a hyphen from the other phase symbols *(table 1)*.

In some areas an association of two soils occurs in such an intricate pattern that they cannot be indicated separately at the scale of mapping. Such a *soil complex* is designated by two fractional symbols separated by a vertical line, e.g.,

$$\frac{847 \mid 752}{2\text{-}2 \mid 3\text{-}2} \quad \text{or} \quad \frac{847 \mid 752}{3\text{-}2}$$

The dominant soil unit (51 to 80 percent of a delineated area) appears on the left.

Unclassified soil areas are usually agricultural or potentially agricultural lands for which, in many cases, soil surveys have already been made by other agencies, such as the U.S. Soil Conservation Service. Symbols for unclassified soils are "100," "200," or "400," but are not in fraction form; sometimes a

letter follows the number indicating further breakdown of the general definition of the symbols, e.g., 200W *(table 1).*

Miscellaneous land types have little or no soil, or soil that cannot feasibly be classified. They are distinguished as a group by the symbol "700," also not in fraction form. Subdivisions within the groups are shown by letter symbols in parentheses following the "700" symbol, e.g. 700(CK) *(table 1).*

Vegetation Symbols

Plant species are represented by letter symbols, such as Af for chamise *(Adenostoma fasciculatum)* and D for Douglas-fir *(Pseudotsuga menziesii) (table 3).* Dominant species in a delineated area (excluding individual grass species and most associated herbs) are indicated by one or more symbols which may be grouped. Each group of symbols represents an element which may be either a broad kind of vegetation (commercial conifers, minor conifers, hardwoods, shrubs, bushy herbs, grass, marsh) or some other landscape unit (nonvegetated and rock, cultivated, urban-industrial). Each delineated area may have one or more elements occupying from 5 to 100 percent of the ground area. Elements can be determined on the map by grouping the appropriate symbols. For example, an area has the symbols Y D I B W Cpo Ci Ba. They represent four elements, respectively: commercial conifers (YDI), hardwoods (BW), shrubs (CpoCi), and non-vegetated (Ba).

Elements are listed in order of abundance with the one listed first making up the greatest proportion of the cover. Likewise, the order of symbols within an element indicates the relative abundance of the species within that element. Symbols of vegetation elements not classified as to species (grass, marsh, and bushy herbs) and the non-vegetation element (barren) are included among plant symbols in proper order of abundance of elements or may stand alone as the case may be.

In the above example, there is a greater proportion of commercial conifers than hardwoods, shrubs, or grass, and there is more Y than D, more D than I. But the proportion of I is not necessarily greater than B or Ba. If five or more species symbols appear in one group, the relative abundance of the species is variable within the delineated area. For further information on the classification system, see the folio titled "Timber Stand and Vegetation-Soil Maps of California," Jan. 15, 1949 (U.S. Forest Serv. California Forest and Range Exp. Stn. 1949), and the "Field Manual, Soil-Vegetation Surveys in California" (U.S. Forest Serv., California Forest and Range Exp. Stn. 1954).

A species must occupy 20 percent or more of the crown space of the element to which it belongs to be mapped in a delineated area. The individual element also must comprise the following minimum parts of a delineated area: crowns of commercial conifers—5 percent or more of the ground space; hardwoods and minor conifers—each at least 5 percent, or 20 percent when in combination with 20 percent or more of commercial conifers; shrubs—at least 5 percent, or 20 percent when in combination with 20 percent or more of a tree element; and all other elements—at least 20 percent if they appear on the map.

In some areas, logging, burning, or clearing may have eliminated one or more (or all) species of commercial conifer trees. In such areas, symbols of conifers eliminated or reduced to less than 5 percent cover are shown in parentheses.

The approximate percent of the ground covered by woody vegetation (i.e., canopy of all trees and shrubs combined) is shown as a *cover* class symbol which appears as a number above or to the left of the vegetation species symbols and separated from them by a line, e.g., 2/YDIBWCpoCiBa. The cover class symbols and explanation are:

	Cover class	*Ground covered (percent)*
Cover symbol:		
1	Dense	> 80
2	Semidense	50 - 80
3	Open	20 - 50
4	Very open	5 - 20
5	Extremely open	< 5

In areas without climate and soil suitable for growing commercial conifer crops, the symbol "N" precedes the cover class symbol in numerator portion of the fraction. "N" is not used in cultivated and urban-industrial areas. This symbol is not used on Soil-Vegetation maps in Shasta and Trinity Counties.

In some areas, distinct vegetation units cannot be shown separately at the scale of mapping. In such cases, two groups of cover class and species symbols are shown with a vertical line separating them, e.g.,

1	2
D	T
R	M
T	Ba

Type-Acre Sampling Plots

Type-acre soil-vegetation sampling plots are established in a mapped area. These plots are not uniformly distributed because their locations are chosen to be representative of the more extensive (or sometimes unusual) combinations of soil and vegetation. A detailed soil profile description and intensive vegetation inventory are made at these sites. Plot locations *(tables 4, 5)* are shown on the map by circled numbers, e.g.,③.

Timber Site Symbols

Site quality (capacity of the land for growing commercial conifer timber) is indicated on the maps by single number symbols (Arabic or Roman) such as 4 and II. For each delineated commercial timber cropland area a predominant site quality class is designated, based on the age-height relationships of trees. The site classification system used depends on the species type and location of the survey area.

The *pine, fir, pine-Douglas-fir,* and *pine–Douglas-fir–fir types* are graded by two different site class curves: (1) in terms of the total height that average dominant trees reach at 300 years of total age by 25-foot class intervals (Dunning 1942), or (2) in terms of the average total height of dominant trees at a base age of 100 years measured at breast height by 20-foot class intervals (Arvanitis, et al. 1964).

Site class symbols are designated by numbers 1 through 7:

	Dunning height (feet)		*Arvanitis height (feet)*
	At 100 years	*At 300 years*	*at 100 years*
Class symbol:			
1	52	75	60
2	67	100	80
3	82	125	100
4	102	150	120
5	122	175	140
6	140	200	160
7	160 (est)	225	180

Dunning's site classes are used in the types surveyed in Del Norte, Shasta, Sonoma, and Trinity Counties. Arvanitis site classes apply to the types mapped in Butte, Calaveras, Plumas, Siskiyou, Tuolumne, and Yuba Counties.

Douglas-fir and *redwood types* are graded in terms of the total height that average dominant and codominant Douglas-fir trees reach at 100 years of age by 30-foot classes (McArdle 1949 rev. 1961). Site class symbols are designated by Roman numbers I through V.

Class symbol:	Height at 100 years *(feet)*
I	200
II	170
III	140
IV	110
V	80

The site curves used have been adjusted to the average height of dominant Douglas-fir trees (Staebler 1948).

Spruce and *lodgepole pine-mountain hemlock* types are each considered a single site quality class:

Symbol	
X	Spruce
XX	Lodgepole pine-mountain hemlock

In areas without climate and soil suitable for growing commercial conifer crops, the site index symbol is omitted.

Soil and Vegetation Boundaries

Soil or vegetation boundaries or both are normally shown on the map by dashed lines. In some places, however, it is necessary to show a soil boundary distinct from a vegetation boundary. Where this is done, a dotted line indicates a soil boundary. When needed, a double-headed arrow is used to show the appropriate adjacent soil.

Other Features on Maps

Photo centers: The locations of the centers of aerial photographs from which the map data are compiled are shown on the map by large dots. This will facilitate use of the map with aerial photos.

Roads: Some are shown for orientation purposes.

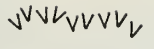
Drainage ways.—Some major drainages are shown for orientation purposes.

Special features: Features too small to delineate are shown by these symbols:


Spring


Wet spot


Small marsh or wet meadow


Rock escarpment


Severely eroded spot


Pond or reservoir


Prominent rock outcrop


Named peak

TABLES TO ACCOMPANY MAPS

Table 1 lists the soil series mapped in the quadrangle and gives some general characteristics of each. The soil series names used here are based on present concepts of the series and are subject to review and correlation. The numbers under the soil name indicate the month and year of the soil series description used as a reference. Date omitted indicates the soil characteristics are not keyed to a specific description but to the soil as described in the area. Local variations must be expected in characteristics listed because terms (except slope class) apply to the soil series in general. Symbols in parentheses indicate the range of slope classes for all phases of the soil series in the quadrangle only. Detailed descriptions of individual soil series are on file at the University of California, Department of Soils and Plant Nutrition at Berkeley and Davis, and Pacific Southwest Forest and Range Experiment Station at Berkeley, California.

Table 2 is a legend of symbols for soil series, phases (excluding slope), and other units mapped. It gives selected behavior characteristics including permeability, general drainage, erosion hazard, hydrologic group, and estimated suitability for commercial timber production and for extensive range use.

Table 3 defines the symbols for plant species and other landscape units occurring in one or more types on the map and symbols of species listed as browse on type-acre sampling plots *(table 4).* Given for each species are scientific name, common name, growth habit, sprouting nature, and browse value. Scientific plant names *(tables 3, 5)* mostly follow Munz and Keck (1959) and Munz (1968). The use of trinomials for "typical" varieties (and subspecies) of species having two or more varieties is in accordance with the International Code of Botanical Nomenclature (1972). The use of a binomial when varieties exist indicates that varieties were not differentiated. Common names mostly follow Jepson (1923), McMinn (1939), and local usage. Browse values are based on and extrapolated from Sampson and Jesperson (1963).

Table 4 presents a portion of the data taken from type-acre sampling plots that is principally concerned with livestock and wildlife use. It includes date of sampling, plot location, aspect and percent slope, soil series and phases, woody cover class (overstory), information on soft chess growing on the plot, percent of ground covered by various vegetation and landscape units as measured below a reference plane 4½ feet above the ground, and a list of woody species with available browse.

The soil series, soil phase, and woody cover class symbols may not correspond to those in the delineated areas of the map in which the plots are located because of scale of mapping. Detailed descriptions of soil profiles at these plot locations are on file at the Pacific Southwest Forest and Range Experiment Station, Berkeley, California.

Soft chess *(Bromus mollis)* is one of the most common annual range grasses in California. Height and stage of maturity of this grass together with date of sampling and other data give an indication of site and kind of season or year for the plot area.

Table 5 lists all plant species recorded for the quadrangle. Although not an exhaustive floristic list for the area, it is quite complete for woody plants in dry upland habitats. Given for each species are scientific name, common name, whether the species was mapped, type-acre sampling plots on which it was found, or whether it was simply observed to occur somewhere in the quadrangle. Scientific names mostly follow Munz and Keck (1959) and Munz (1968). Common names mostly follow Abrams (1923-1960), Jepson (1923), Munz and Keck (1959), Munz (1968), and local usage. Because percent ground cover (see table 4) and species composition of herbaceous component of vegetation often vary from

year to year, these data are preliminary and describe plots at date of sampling. More data on percent composition and abundance of species are on file at Department of Agronomy and Range Science, University of California, Davis and at Pacific Southwest Forest and Range Experiment Station, Berkeley, California.

Table 6 lists the current taxonomic classification of the soils found in the quadrangle, according to National Cooperative Soil Survey standards.

The soil classification system currently used was adopted for general use in the United States in 1965 (Basile 1971; Soil Survey Staff 1960). It has six categories. The broadest category is the order, followed by suborder, great group, subgroup, family, and the series. The criteria used as a basis for classification are soil properties that are observable and measurable. The placement of the smallest unit—the soil series—in the current system may change as more precise information becomes available.

The 10 soil orders recognized are defined as follows:

Entisols: young mineral soils that do not have genetic horizons or barely have the beginning of such horizons.

Inceptisols: mineral soils in which horizons have started to develop, and are young but not on recent land surfaces.

Mollisols: very dark colored and base-rich soils with a thick, friable, dark-colored surface layer.

Alfisols: soils that have clay-enriched B horizons with medium or high base saturation and usually have light-colored surface horizons.

Ultisols: well developed soils that have clay-enriched B horizons with low base supply or low base saturation decreasing with depth.

Vertisols: clayey soils that shrink and have wide deep cracks during dry periods and that swell closing the cracks, in moist seasons.

Aridisols: primarily soils in dry areas, pale in color and generally soft when dry or have distinct structure.

Spodosols: usually gray to light gray podzol or podzolic soils, generally infertile, and developed from siliceous parent materials in cool humid climates.

Oxisols: reddish, yellowish, or grayish soils of tropical and subtropical regions, are deeply weathered, and formed on gentle slopes on old surfaces.

Histosols: soils that are dominantly organic from bogs, peats, and mucks.

REFERENCES

Abrams, Leroy.
1923-1960. Illustrated flora of the Pacific States. 4 vols. Stanford: Stanford University Press.

Arvanitis, L. G., J. Lindquist, and M. Palley.
1964. Site index curves for even-aged young-growth ponderosa pine of the west-side Sierra Nevada. California Forestry and Forest Products 35, 8 p.

Basile, Robert M.
1971. A geography of soils. Dubuque, Iowa: Wm. C. Brown Co. 152 p., illus.

Eleventh International Botanical Congress.
1972. International code of botanical nomenclature. Adopted August 1969. Utrecht, Netherlands, 2 p.

Jepson, Willis Lynn.
1923-1925. A manual of the flowering plants of California. 1,238 p. illus. Berkeley: California Associated Students Store.

McArdle, Richard E., W. H. Meyer, and D. Bruce.
1930. The yield of Douglas fir in the Pacific Northwest. Rev. 1949 and 1961. U.S. Dep. Agric. Tech. Bul. 201, 64 p.

McMinn, Howard E.
1939. An illustrated manual of California shrubs. 698 p., illus. San Francisco: J. W. Stacey, Inc.

Munz, Philip A.
1968. Supplement to a California flora. 224 p. Berkeley: University of California Press.

Munz, Philip A., and David D. Keck.
1959. A California flora. 1,681 p., illus. Berkeley: University of California Press.

Sampson, Arthur W., and Beryl S. Jesperson.
1963. California range brushlands and browse plants. Calif. Agric. Exp. Stn. Ext. Serv. Manual 33, 162 p.

Soil Survey Staff.
1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 p. illus.

Soil Survey Staff.
1960. Soil classification, a comprehensive system, 7th approximation. Soil Conservation Serv. Washington, D.C. 265 p., illus.

Staebler, George R.
1948. Use of dominant tree heights in determining site index for Douglas-fir. U.S. Forest Serv. Pacific Northwest Forest and Range Exp. Stn. For. Res. Note 44, 3 p.

U.S. Forest Service, California Forest and Range Experiment Station.
1949. The timber stand and vegetation-soil maps of California. Berkeley, Calif. 15 p., illus.

U.S. Forest Service, California Forest and Range Experiment Station.
1954. Field manual, soil-vegetation surveys in California. Berkeley, Calif. 95 p., illus.

GPO 689-225/4405

Colwell, Wilmer L., Jr.

1974. Soil-vegetation maps of California. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif. 6 p., illus. (USDA Forest Serv. Resour. Bull. PSW-13)

This bulletin provides an explanation of the map symbols and other information common to all 7½ minute quadrangles prepared by the State Cooperative Soil-Vegetation Survey. The bulletin is designed to accompany each map in the series. A group of six tables of soil and vegetation data characteristic of that area is also supplied with each map.

Oxford: 182.58(794) + 114.7(794).
Retrieval Terms: soil surveys; vegetation surveys; soil-vegetation maps; user information.

Colwell, Wilmer L., Jr.

1974. Soil-vegetation maps of California. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif. 6 p., illus. (USDA Forest Serv. Resour. Bull. PSW-13)

This bulletin provides an explanation of the map symbols and other information common to all 7½ minute quadrangles prepared by the State Cooperative Soil-Vegetation Survey. The bulletin is designed to accompany each map in the series. A group of six tables of soil and vegetation data characteristic of that area is also supplied with each map.

Oxford: 182.58(794) + 114.7(794).
Retrieval Terms: soil surveys; vegetation surveys; soil-vegetation maps; user information.